Space Weather Technical Forecast

Issued on Wednesday, 03 November 2021 at 00:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of further M-class flares. G1/Minor G2/Moderate geomagnetic storms likely, and slight chance of G3/Strong geomagnetic storms late day 1 into day 2.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: There are three sunspot regions on the visible disc with moderate solar activity observed over the last 24 hours. The moderate activity was a result of long duration M1.7 flare peaking around 02/0300UT from the region AR2891 (Dac/Beta), which resulted in an Earth directed halo CME. AR2887 (Hsx/Alpha) rotating off the southwest limb, also produced several flares and CME's, although final computation is necessary, none of these are expected to be earth directed. AR2893 (Hsx/Alpha) in the northeast quadrant appears stable with very little recent activity.

Solar Wind / Geomagnetic Activity: Solar wind parameters indicated a continued connection to the high speed stream from coronal hole 16. Solar wind speeds increased through the period, and are currently around 600km/s. Density started slightly above average, 12ppcc, but has generally been on a declining trend. Total IMF, Bt, also started at moderate levels, 12nT, but soon trended back to weak levels. The north-south component, Bz fluctuated between peaks of +5nT and -8nT, again with a generally decreasing variability trend through the period. Phi angle was mostly positive (away from the sun) with only brief negative (towards the sun) fluctuations. Geomagnetic activity was Unsettled initially with a G1/Minor Storm interval, then became quiet.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured by GOES-16 remained slightly elevated but below the S1 level. The high energy electron flux (greater than 2 MeV) was mainly at background or moderate levels with the associated 24-hour electron fluence below the Active (1e8 integrated pfu) threshold, and with 4.61e6 integrated pfu recorded at 03/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to remain mainly low through the next four days, but with a continuing chance of M-class flares from AR2891.

Solar Wind / Geomagnetic Activity: The HSS from coronal hole 16 is expected to continue to influence earth on day 1 (3rd). A continued slight chance of glancing blows from small CMEs on days 1 and 2 (3rd and 4th) remains possible, but the main arrival of the halo CME, associated with the M1 flare from 2891 around 02/0300UTC is expected to be either late on day 1 or early day 2, with a current estimated arrival of 0001 UTC on the 4th. Quiet to Active geomagnetic conditions are forecast to predominate through the next four days, though the arrival of this halo CME brings a likelihood of G1/Minor G2/Moderate storm intervals at or after its arrival with a slight chance of G3/Strong storm intervals.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be below the S1 minor storm level, and generally decreasing towards background values. The high energy electron flux (greater than 2 MeV) is forecast to be at mainly

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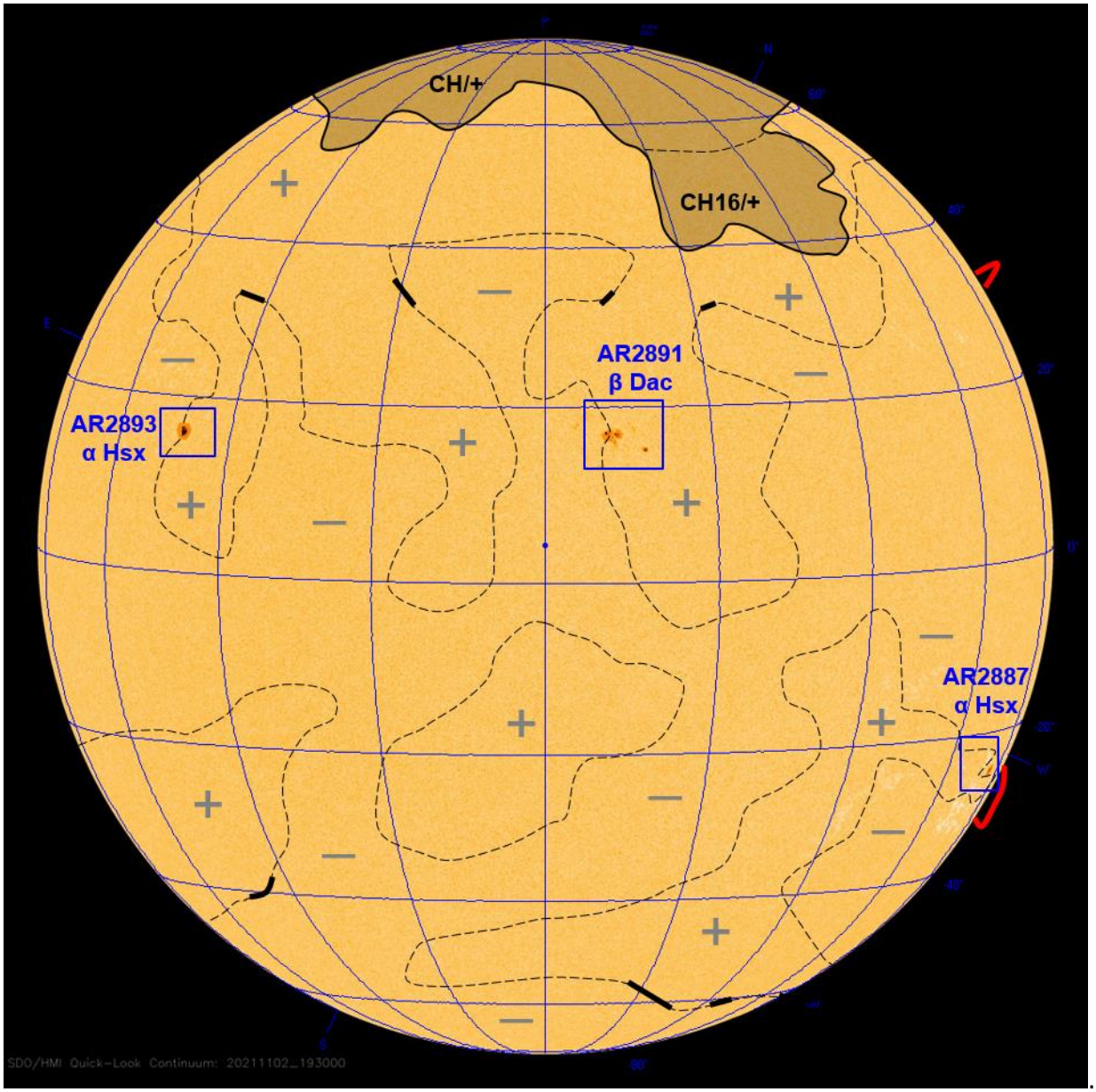
background to moderate levels, with an increasing chance of reaching sustained moderate or occasionally high levels through the period especially towards days 3 and 4 (5th and 6th) . Corresponding 24 hour electron fluence values are expected to remain below the Active (1e8 integrated pfu) level during days 1 and 2 (3rd and 4th), although a rising trend is likely after the effects of the HSS and CMEs wane through days days 3 and 4 (5th and 6th).

Figure 1. Solar Analysis Valid 02/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The solar wind currently remains heavily influenced by the connection with coronal hole 16, and remains around 600 km/s. Unsettled or active intervals are most probable through the early part of day 1 (3rd), but this will likely rise to G1/Minor or G2/Moderate storm intervals with a slight chance of G3/Strong storm intervals late on day 1 (3rd) or into day 2 (4th) due to the arrival of the halo CME which originated from the M1.7 flare at 02/0300 UTC.

A couple of glancing blows from CMEs remain possibe between days 1 to 2 (3rd to 4th). The first is from the CME which left the Sun on 31st October, and possible on day 1 (3rd). The second from a CME which left the sun on 1st November which may glance Earth on day 2 (4th).

No further CME's have been detected for days 3 or 4 (5th or 6th), and no other coronal hole influences are expected, leading a decreasing risk of geomagnetic storms.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	70	70	30	10
Strong	G3	No	20	20	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/0451	Full	M Flare from AR2891	Centre	1100	04/0001 UTC	Direct hit likely, possibly two shocks 12-24 hours apart.

Figure 2: Real Time Solar Wind for past 24 hours.

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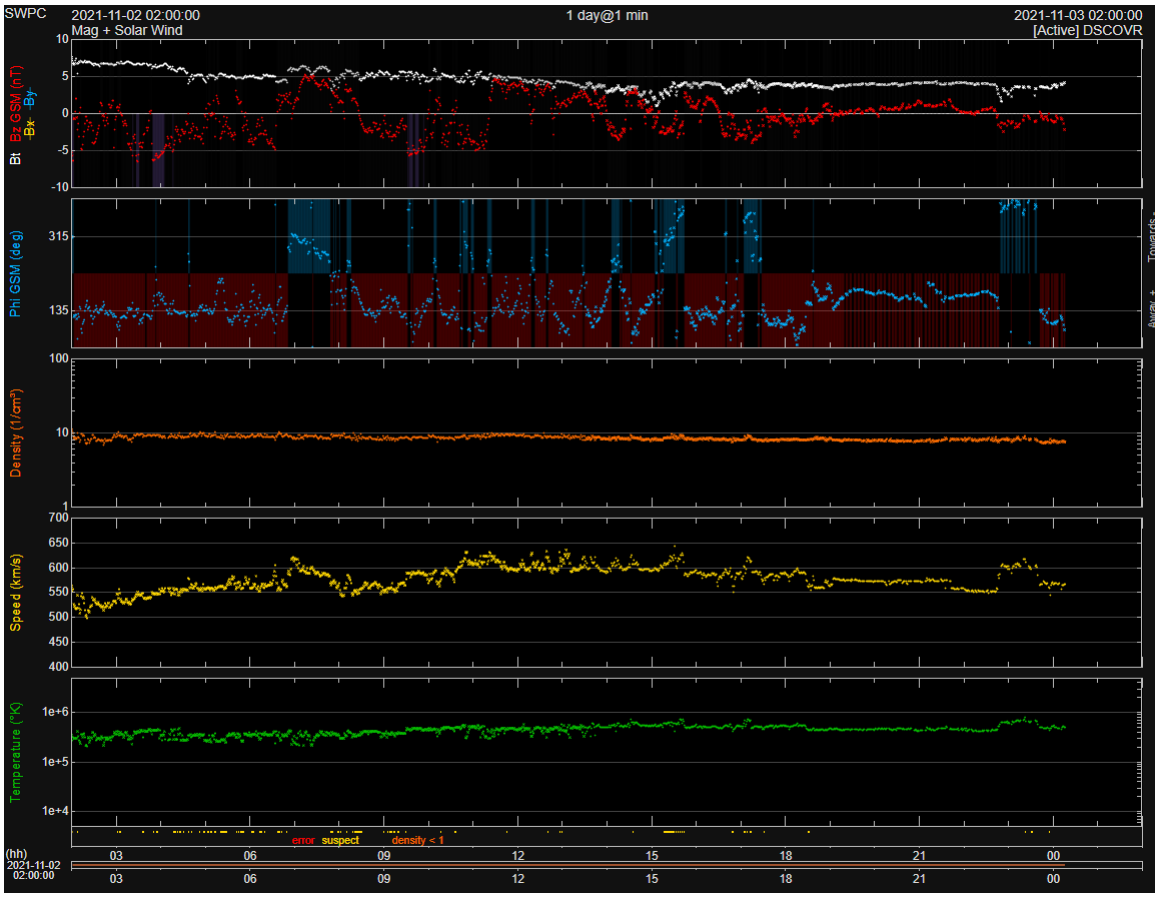
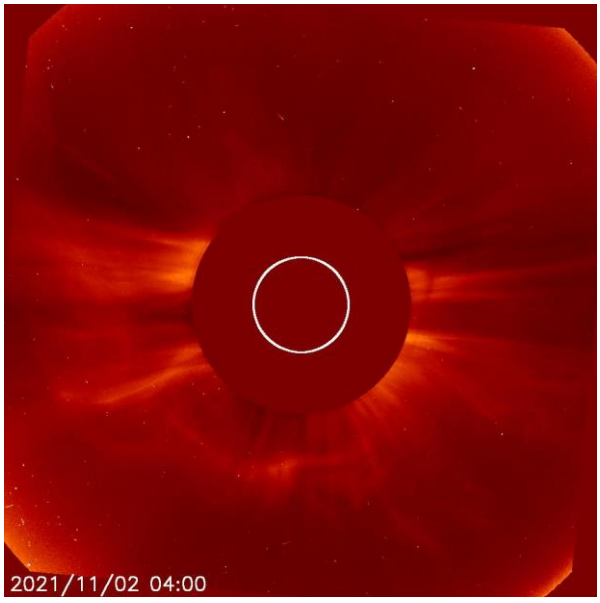


Figure 3: Full Halo CME as seen by SOHO LASCO C2 Imagery.



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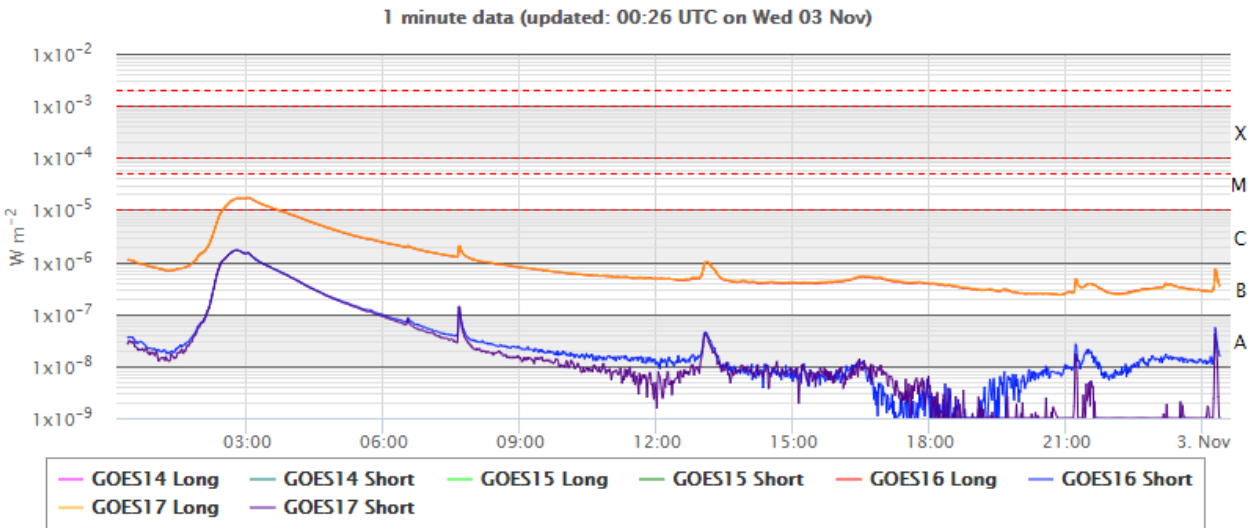
Radio Blackouts - X-Ray Flares:

Solar activity is expected to be mainly low, with an ongoing likelihood of C-class flare activity and a chance of M-class flares. The main risk region is AR2891 (Dac/Beta), which gave a long duration M1 flare peaking around 02/0300UTC. AR2887 (Hsx/Alpha) has become increasingly simple, yet has a history of significant flare activity and continues to produce C-class flares and CMEs as it approaches the southwest limb.

AR2893 (Hsx/Alpha) in the northeast quadrant appears to be relatively benign with no real signs of recent significant development.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	30	30	30
Very Active	R3 to R5 X Class	No	3	3	3	3

Figure 4: Xray trace past 24 hours.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is below S1/Minor storm levels. The trend has remained largely steady for the last 24 hours, with brief slight elevations in the values of the lower energy protons, most likely due to the M-class flare on 01 November. Further minor enhancements from significant flaring remain possible.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: Proton Trace Past 24 hours

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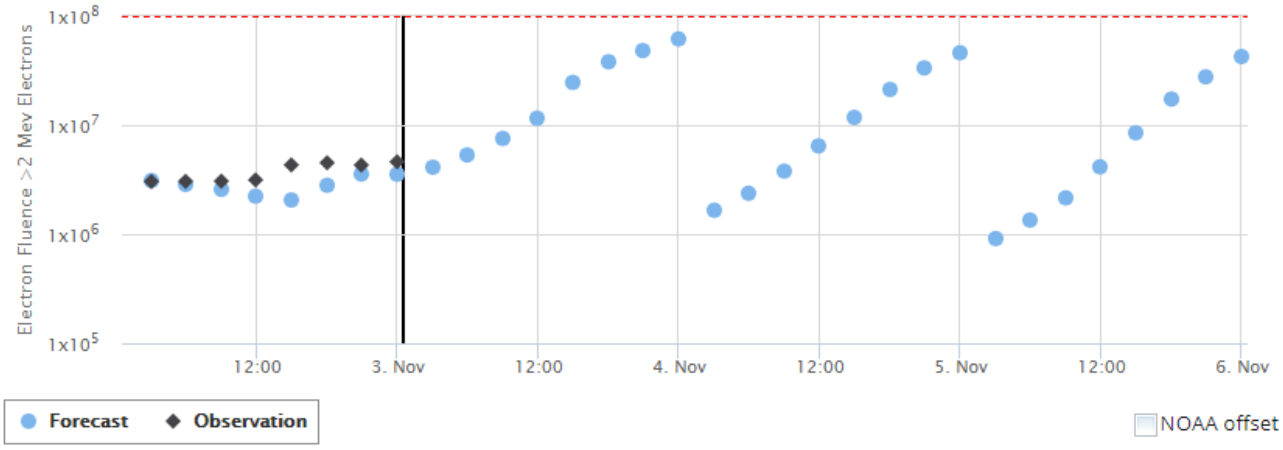
High Energy Electrons Event (≥ 2MeV):

High energy electrons (greater than 2MeV) are currently at mainly background levels, with increases to moderate values during the diurnal peak. The high speed stream from coronal hole 16 may lead to an increase in values through days 2 to 4, perhaps reaching sustained moderate, occasionally high levels. However any increase is subject to potential CME arrivals on days 1 and 2, which may glance the Earth and lead to a disruption of the radiation belts.

Electron fluence values are forecast to remain below the Active (1e8 integrated fluence) threshold through the first two days with a chance of rising above during days 3 and 4 (5th and 6th).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	30	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	2

Figure 6: REFM observation and forecast.



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